National Renewable Energy Laboratory

SOLICITATION FOR LETTERS OF INTEREST (LOI) NO. RDJ-0-30620-00

"HIGH PERFORMANCE PHOTOVOLTAICS, PHASE I: IDENTIFYING CRITICAL PATHS"

READ THIS DOCUMENT CAREFULLY

This solicitation is being conducted under the streamlined procedures for competitive subcontracts established by the National Renewable Energy Laboratory (NREL). We will award subcontracts based on:

- **TECHNICAL APPROACH**
- **BEST COMBINATION OF QUALITATIVE MERIT CRITERIA AND PRICE**

Issue Date: April 17, 2000 **Due Date: June 12, 2000**

********Technical questions must be **received in writing** no later than **May 15, 2000** and can be faxed to Vicki Riddell (303) 384-7310.*******

1.	**Solicitation Type**	Streamlined Best Value
2.	**Submit Letters of Interest to**	National Renewable Energy Laboratory Attn: Vicki Riddell, M/S 2713 1617 Cole Boulevard Golden, CO 80401-3393
3.	**For Information Contact**	Vicki Riddell, Contract Administrator Phone: (303) 384-7457 Fax: (303) 384-7310 E-mail: vicki_riddell@nrel.gov

4. BACKGROUND/OBJECTIVES

The purpose of the High Performance Photovoltaics (HiPer PV) Initiative is to substantially increase the viability of photovoltaics (PV) for cost-competitive applications so that PV can make a significant contribution to our energy supply and to our environment in the 21st century. This will be done by exploring the ultimate limits of performance of existing PV technologies, approximately doubling their sunlight-to-electricity conversion efficiencies during the course of the program. This includes bringing thin film cells and modules toward 25% and 20% efficiencies, respectively; and multijunction concentrators to be able to convert *more than a third of the sun's energy* (33% efficiency) to electricity by 2010. These efficiencies, challenging though they are, are still well below theoretical limits for converting sunlight to electricity using PV devices.

Today, PV is well-over a billion dollar worldwide industry with about 200 megawatt of sales in 1999, growing at about 20% per year. US-based manufacturers have a large share of this global market. Despite PV's usefulness for many high-value markets, today's PV is too expensive to compete with conventional utility-generated electricity either in distributed or centralized forms. To become competitive, the cost of PV electricity must be reduced significantly, and we expect this to be done by substantially advancing the state-of-the-art of key PV technologies. Fortunately, the US PV community leads the world in potentially cost-competitive PV technologies and is well-positioned to dominate PV's development and use for future, multi-gigawatt energy markets. **HiPer PV intends to further this leadership position.**

If current growth rates can be sustained, installed PV systems will produce about one Quad annually in 2020 and about five Quads in 2030. (In sunny climates, 50 GW_p of PV would produce about one Quad of energy annually.) PV will likely continue this explosive growth beyond 2030 and reach even higher levels later in the 21st century. **HiPer PV is meant to assure that the US can *accelerate* the development of PV during the 21st century** to meet our significant economic and environmental needs for clean energy, including worldwide reduction in carbon dioxide emissions.

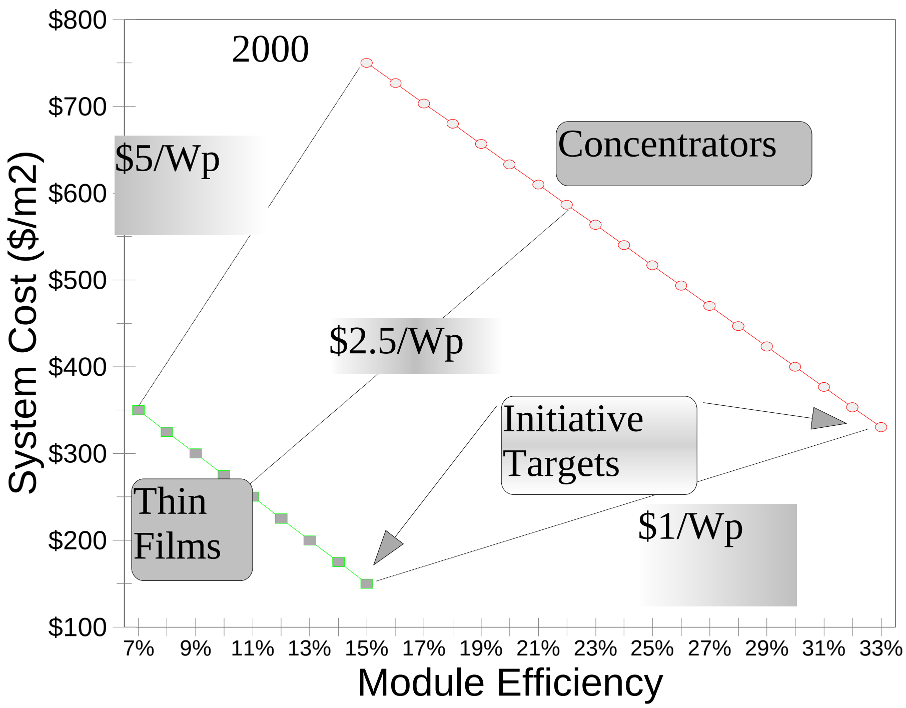

Figure 1. Scenarios for concentrator and flat plate systems with various efficiencies and manufacturing costs. Today's systems are on the left (higher costs, lower efficiencies); the system targets for the HiPer initiative are on the bottom right and translate to about $1/W$$_p$ installed system cost (excluding profit), a cost reduction of about 80% from today's systems. (PV system cost in $/W$$_p$ is calculated as a function of the cost of system components in $/m^2 combined with the efficiency with which they convert sunlight to electricity in watts/m^2.)

The HiPer PV Initiative is designed to support research to double the sunlight-to-electricity conversion efficiencies of key photovoltaic (PV) technologies in order to accelerate and enhance their impact in the marketplace. Along with the other key criteria for success in PV (module manufacturing cost and reliability, which are central to other components of the DOE National PV Program), *module sunlight-to-electricity conversion efficiency is a key parameter driving the economics of PV-generated electricity (see Figure 1, above)*. Simply put, raising sunlight-to-electricity conversion efficiency reduces cost per unit of electrical output. The pathway to increased efficiency is via research on semiconductor materials and processes for PV cells and modules. The HiPer PV Initiative will direct Federal resources toward advances that have the potential to help PV become a widespread, energy-significant technology.

HiPer PV believes that high-flux concentrators using high-efficiency multijunction cells; simple, single-axis concentrators using thin film cells (such as $CuInSe_2$, or CIS, on stainless steel); and low-cost multijunction thin films for large-area, monolithically interconnected flat-plate modules have great potential for improvement and low cost. Each of these technologies appears to have the potential to reach an installed system *cost* goal of about $\$1/W_p$ (see figure) with continued progress in efficiency, reliability, and manufacturing cost. (Throughout this LOI, a system *cost* of $\$1/W_p$ and a AC system *price* of $\$1.5/W_p$ are treated as equivalent.) The HiPer PV Initiative aims to focus research on raising the efficiency of these PV technologies so that they can compete with conventional, utility-generated electricity. In addition to performance-oriented research on thin films and concentrators, fundamental research will also receive support in order to strengthen the scientific foundation on which thin films and concentrators build progress toward large-volume production.

Table 1 - HiPer PV Program Targets

Targets	Date	Phase (Task Type and Sequential Number within that Task)
T1. Demonstrate a 20% Efficiency Thin Film Cell under Low Concentration	2001	Phase I (Thin Film Concentrator #1)
T2. Identify Key Issues and Pathways to Achieving a 33% Concentrator Module	2002	Phase I (III-V Concentrator #1)
T3. Identify Key Issues and Pathways for Achieving a 25% Thin Film Multijunction Cell	2002	Phase I (Thin Film Multijunction #1)
T4. Demonstrate a 34% Cell under Concentration	2003	Phase II (III-V Multijunction #2)
T5. Fabricate a Thin Film Minimodule of 15% Efficiency	2005	Phase II (Thin Film Multijunction #2)
T6. Produce on an Industrial Pilot Line a 20%-Efficient Prototype Thin Film Cell Suitable for Integration into a Pre-existing Concentrator Module Technology	2006	Phase II (Thin Film Concentrator #2)
T7. Demonstrate a 40% Cell under Concentration	2008	Phase III (III-V Multijunction #3)
T8. Demonstrate a Thin Film Cell of 25% Efficiency	2009	Phase III (Thin Film Multijunction #3)
T9. Demonstrate an Experimental 20%-Efficient Multijunction Thin Film, Flat-Plate Minimodule (more than one cell)	2010	Phase III (Thin Film Multijunction #4)
T10. Demonstrate a 20% Single-Axis Concentrator Using a Potentially Low-Cost Thin Film Cell	2010	Phase III (Thin Film Concentrator #3)
T11. Demonstrate the Translation of III-V Concentrator Cell Results to a Pre-commercial Concentrator Module of 33% Efficiency	2010	Phase III (III-V Multijunction #4)

The goal of DOE-sponsored PV research is to reduce the cost of PV electricity to make PV cost-competitive for energy-significant uses. With a focus on high efficiency, the payoff of the HiPer PV will be:

C **Development of Thin Film Multijunctions as a Next-Generation Follow-on to Existing Single-Junction Thin Films (which are limited in their efficiency potential to about 15% modules).**

- **Development of Thin Films for Low-Cost, Single-Axis Concentrators**

C **Development of Ultra-High-Efficiency Concentrator Cells for Cost-Effective High-Flux Concentrators**

Through increasing the efficiency of key PV technologies, *HiPer PV will help assure that PV electricity will be inexpensive enough to be used in the US and worldwide to produce globally significant amounts of clean, sustainable electricity for the 21st century.*

The PV Industry Twenty Year Roadmap

The PV industry has stated critical PV system cost and production targets for the twenty year period 2000 to 2020. HiPer PV is a fundamental research initiative that is meant to support efforts that align with these targets for the period *after 2010*. The key targets from the Twenty-Year Roadmap (See Figure 2 for price targets) are:

1. Capacity Increases
    - Increase Capacity by 25% per year through 2020
    - In year 2020, ship about 7 GW_p of PV product
2. System Prices
    - Reduce PV System Prices (installed, AC grid tied) to \$3/W_p in 2010 and \$1.5/W_p in 2020 (note that data shown in Figure 1 are direct manufacturing *costs*, where \$1/W_p is assumed to be approximately the same as a system price of \$1.5/W_p).

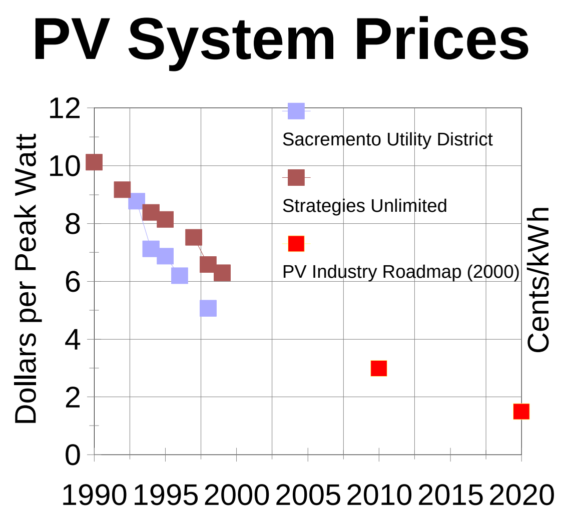

Figure 2. Historical and projected PV system prices from the PV Industry Roadmap (2000)

Although HiPer PV aligns with these goals, its focus is on enabling technologies that will only be commercialized after the close of the ten year period of the HiPer PV initiative. As such, HiPer contributes to the goals between 2010 and 2020.

UNIQUE APPROACH

Two aspects of the HiPer PV Initiative differ from previous NREL-funded initiatives (e.g., PV MaT, Thin Film Partnership, others):

- HiPer PV is a ten-year program that will have a three-phased approach that includes an initial two-year period, "Identifying Critical Paths" (*this LOI*); a longer second Phase, "Implementation"; and a final Phase, "Prototype Finalization."

- NREL researchers will be active participants in the HiPer PV effort, in some cases leading multidisciplinary national teams that will include industry and university researchers funded by this LOI. *(However, note that NREL or Sandia cannot be lower-level contractors on ANY letter of interest; nor should any Interested Party make ANY claim concerning specific collaborations with NREL or Sandia. The inclusion of NCPV research activities in the Interested Party's letter of interest would make the Interested Party ineligible for funding.)*

The focus of the two-year subcontracts in Phase I ("Identifying Critical Paths") is to tackle the inherent complexities of the chosen cutting-edge technologies and capture a set of approaches that can then form the center of further progress toward the Targets in Phases II and III.

NREL in-house research has skills that are well-known to the community in thin film and III-V concentrator cells. This expertise also includes materials and device characterization and stability testing. National Center for Photovoltaics (NCPV) expertise will be an integral part of the HiPer PV activity; NCPV researchers will participate in an organized manner with the university and corporate awardees of this LOI. In some cases, NCPV researchers will manage and coordinate major HiPer PV activities. Expectations are that university awardees will support the effort to meet the stated targets through fundamental and innovative research. They will work on Teams with both NCPV and corporate researchers. Corporations will be expected to work towards the prototype pre-commercial module goals in collaboration with NCPV and university researchers.

HiPer PV is accepting letters of interest in two categories (see Scope of Work, below): Thin Film Multijunctions and Concentrators; and III-V Concentrators. Individual proposals should provide specific statements of work that support timely progress toward the HiPer PV targets given in Table 1 (above). (Another solicitation, "Photovoltaic Technologies Beyond the Horizon," RFP RCQ-0-30619, is currently available from NREL (at www.nrel.gov/ncpv/solicitations.html) and is open to a broader set of innovative topics.)

The Three Phases of HiPer PV

This LOI covers the first two-year Phase of HiPer PV, but the expected period of the entire HiPer PV is ten years. Three Phases are scheduled: this first one, to identify problems, approaches, and alliances; a second one to implement the approaches and alliances; and a final one to bring work to fruition in terms of pre-commercial, prototype products (modules). Information gained in Phase 1 (and in Phase 2) will help to select the most promising approaches for funding in subsequent Phases. Except for the fundamental research that can best be done by a single organization, letters of interest that bring together needed expertise (for example, in concentrators: cell, optics, thermal management, systems issues) are encouraged.

Each Phase will be individually competed, so participation in a prior Phase does not guarantee continued funding. And absence from a prior Phase will not eliminate potential Interested Parties from subsequent Phases.

Alliances and Partnerships

NREL recognizes that several of the Targets in HiPer PV require multidisciplinary efforts. Two kinds of joint activities are envisioned within HiPer PV: Those that are formally part of an Interested Party's letter of interest (i.e., where an Interested Party has lower-tier subcontractors performing needed activities) and less-formal collaborations in which different awardees join together with NREL to carry out complementary tasks. In the latter case, such alliances will be created after the LOI awards have been completed.

5. SCOPE OF INTEREST

A. Thin Film Multijunctions and Concentrators

HiPer PV is soliciting thin film research in two areas: multijunctions (Task A1) and concentrators (Task A2). Thin films, which were originally designed for their low-cost potential, have achieved reasonable efficiencies in the 15%-20% range. As such, they are new candidates for both higher performance multijunctions and for simple, single-axis concentrators. (In this LOI, thin films are meant to include only those PV materials deposited on low-cost substrates and with the potential for low-cost manufacturing.)

By combining high-band gap and low-band gap single-junctions, it should be possible to fabricate thin-film multijunction cells with *efficiencies over 25%.* Among the leading candidates for thin film bottom cells are $CuInSe_2$ and low-band gap CdTe alloys. Candidate top cells include $Cu(In,Ga)(S,Se)_2$, and higher band gap CdTe alloys.

To-date, limited work has been done on polycrystalline thin- film multijunction cells. Two of the barriers have been transmission through the top cell (especially losses due to free-carrier absorption of long wavelengths in the top and bottom transparent contacts); and interdiffusion at high processing temperatures in two-terminal designs, causing loss of performance.

Another serious challenge is device design: Should a two or four-terminal approach be used? One of HiPer PV's goals for Phase I is to make this choice clearer. There are distinguishing factors of cost and performance associated with two- and four-terminal designs, with different aspects of complexity, performance potential, and manufacturing challenges.

In terms of thin films for concentrators, HiPer PV sees an opportunity to exploit the reasonable performance but low cost of thin films. An example is CIS on stainless steel. Cells of 17% efficiency (measured at one sun) have been made, and this design lends itself to the thermal dissipation needed in concentrators. Thin films have the potential to reduce cell cost in single-axis concentrators, which is an important component of total system cost at these low concentrations.

NREL is an acknowledged leader in high-efficiency CIS and CdTe cells. NREL in-house researchers are engaged in ongoing work to develop multijunction cells using CIS, CdTe, and their alloys; and to use CIS for concentrators. NREL will be well-positioned to collaborate with awardees of this LOI.

Task A1. High-Efficiency Thin-Film Multijunction Cells and Modules (Targets T3, T5, T8, T9)

Hiper PV solicits research on thin-film multijunctions that have the potential to achieve our stated targets for cells (over 25%) and prototype minimodules (20%). Examples of such work include but are not limited to:

- For top cells: research on high band gap CIS alloys; CdTe and related higher band gap alloys; other innovative approaches;
- For bottom cells: research on low band gap CIS and its alloys; thin Si; and other innovative approaches;
- For two-terminal cells: monolithic interconnections of high-and-low band gap cells (including transparent, conductive oxides); low-temperature processes or other schemes to minimize interdiffusion and related performance degradation during fabrication; and innovative approaches;

- For four-terminal cells: appropriate designs using today's thin film top/bottom cells; and innovative designs/cell combinations.

Letters of Interest may include combinations of these approaches, specific aspects of them, or even new ideas that are not included here, as long as they are aimed at our stated Targets from Table 1 for thin film multijunctions (which, by implication, must eventually be manufacturable at a low cost).

Task A2. Thin Film Cells for Single-Axis Concentrators (Targets T1, T6, T10)

Another pathway to low cost is to use simple, low-concentration modules with single-axis tracking combined with low-cost, but high-efficiency, thin-film cells. For those modules, cell design, heat dissipation, and low cost are important. The target of this Task is to reach a 20%-efficient prototype module in 2010.

It has been shown by NREL models that a band gap between about 1.1 and 1.5 eV is optimal for low-flux concentrators. CIGS cells on thermally conductive substrates can be used for this application. NREL has experimented with CIGS on stainless steel and achieved reasonable efficiencies (over 17% AM1.5, one sun). This Task will aggressively support improving cell efficiencies and transitioning cells to prototype concentrator modules.

B. III-V Concentrators

The primary costs for concentrators (optics, tracking, installation, etc.) can be leveraged by using very high efficiency solar cells. In fact, at sufficiently high concentration levels, the cost of a properly designed cell can be a very small part of the total cost. The goal of this part of the solicitation is to *do the fundamental research needed for a 33%-efficient prototype of a concentrator module*[*] *that could, with further engineering, become a marketable product*. While the economics for costly substrates like GaAs suggest that a high flux will be needed, NREL does not wish to arbitrarily dictate a specific concentration range.

A 33% module requires a very high efficiency (probably >40%) solar cell. Theoretically, the efficiency of a 4-junction concentrator cell could surpass 50%, implying that a >40% cell is realistic. There are, potentially, hundreds of approaches to achieving a 40% efficiency. The technical issues associated with approaches using single-crystal materials are elaborated here, but other approaches may also be fruitful.

The "ideal" concentrator cell would acquire all of its junctions on a single substrate in a single-growth run. To achieve this, materials with appropriate band gaps, lattice constants, and quality must be identified. For example, the GaInP/GaAs/Ge cell that achieved 32% efficiency could reach 40% if a GaAs-lattice-matched, 1-eV material with good quality could be identified as the third component cell between Ge and GaAs subcells. NREL researchers are conducting fundamental research into III-V alloys, such as III-N-V or B-III-V, that might be incorporated into that structure. If the lattice-matched criterion is relaxed, more materials are available, but the challenges associated with growing high quality material with good yield are increased.

It may be easier to achieve a 40% efficiency with a mechanical stack of solar cells grown on two different substrates. In this case, less work is required to develop new materials, but the fabrication of a 33% module will require learning how to stack the cells so that the temperature of the cell is kept low while still making appropriate electrical and optical interconnection of the cells. Techniques developed by the semiconductor industry for integrating Si, GaAs, and InP may be useful. Approaches requiring two single-crystal substrates are likely to be more expensive, increasing the concentration needed to make a marketable system, and, therefore, increasing the technical challenges associated with high flux.

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[*] 'Concentrator module' is used here to refer to the cells, optics, heat sink, and the associated connections and structure.

For all approaches, fundamental research is needed to perfect the quality of the materials, passivation of the front and back of each subcell, and interconnecting tunnel junctions. Broadband anti-reflection coatings and thermally reflective layers may be useful toward capturing the useful light while rejecting useless radiation. Device design that mitigates losses from series resistance is essential for concentrator cells. This problem becomes more severe as the concentration is increased or the the cell area is increased. For high-concentration and/or high-cell-area applications, it may be necessary to interconnect small-area cells to produce a high-voltage device on a single substrate.

While issues associated with cell degradation need not be solved to achieve a 33% module, history teaches that overcoming degradation mechanisms sometimes requires years of fundamental research and that they are best studied early on rather than after a technology is put into the field. Even though lasers are operated at higher currents, use of germanium substrates, tunnel junctions, or some other component may cause instabilities in the solar cells. While flat-plate cells can be light soaked in the lab, it is much more difficult to age cells under 1000X illumination. The cheapest way to identify degradation mechanisms at high flux may be to use the sun as the light source, requiring fabrication of an outdoor concentrator system.

Achievement of a 40% cell is no guarantee of a 33% module. Losses associated with the optics or increased cell temperature are significant. Fundamental research on thermal management, flux uniformity, optical efficiency, etc., may be required to reach 33% module efficiency.

Thermal management for small-area cells (probably passively cooled) may be qualitatively different than thermal management for a large-area receiver (probably actively cooled). However, some fundamental research might be applicable to both kinds of modules. For example, if the cell is made in such a way that the below band gap light is reflected, the thermal management is improved in both systems.

While solar thermal systems are not hindered by variations in flux density at the target, solar cells that are connected in series suffer a large loss unless every cell receives the same amount of light. While it may be possible to vary the sizes of the cell to compensate for any flux nonuniformities, variations in alignment may cause movement of the image, defeating this scheme. Concentrators that have one cell at the focus of each identical lens may still suffer from flux nonuniformity because of chromatic aberrations (which can be problematic for multijunction cells). Chromatic aberration losses may be mitigated by modifying the optics or by modifying the cells.

Optical efficiency can be improved by increasing the reflectivity of mirrors or decreasing the reflectivity and absorptivity of lenses. However, the optical efficiency can also be increased in less obvious ways. Diffuse light is scattered preferentially at low angles. A module that is able to collect light with a 2° acceptance angle will collect light that is missed by a module with a smaller acceptance angle.

The progress of fundamental research often requires a capability to model optical, heat, and electrical transport. Progress in all of these areas may be facilitated by development of models and the associated computational resources.

There are several issues, e.g., the appropriate spectrum, to be resolved concerning the measurement of high concentrator efficiencies. The NCPV will explore these issues throughout the High Performance Initiative. The NCPV will determine if the goals of the research projects have been met by measuring the efficiency of concentrator cells at 25 °C, with ASTM E892 direct spectrum, and with the area defined as the total area minus the bus bar area, and by measuring concentrator modules at 20 °C air temperature, 850 W/m^2 direct irradiance and 4 m/s wind speed with the area defined as the receiver aperture area. Alternatives to these reference conditions will be explored in the future.

Task B1. High Efficiency III-V Multijunction Cells Suitable for High-Flux Systems (point-focus or mini-module configurations) (Targets T2, T4, T7, T11)

HiPer PV seeks letters of interest for fundamental research leading toward achievement of a 33% pre-commercial module. The fundamental research may be directed toward studies of materials, device design, device degradation, optics, thermal management, or other studies related to a 33% module. The research may be directed toward components (e.g. optics) or toward research modules (integration of cells, optics, cooling). The discussion above describes the types of research that HiPer PV anticipates, but letters of interest are not limited to these topics. The letter of interest must describe the intended research, what is and isn't known about this topic, and why the proposed research is expected to contribute toward a 33% module. Although letters of interest to the initial phase of funding may focus on specific fundamental research problems; in future phases, participants will be expected to form multidisciplinary partnerships so as to provide the total expertise needed to put together a 33% module.

Selected Bibliography

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4. Richard Swanson, 2000, "The Promise of Concentrators," Progress in PV, Vol. 8, p. 93-111.
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6. "Millennium Special Issue, PV2000 and Beyond," K. Zweibel and M. Green (eds), Progress in Photovoltaics, John Wiley, January 2000, V. 8 #1.
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8. "PV Energy Program Contract Summary, FY1999," Feb. 2000, US DOE, GO-102000-0976.
9. "US PV Industry PV Technology Roadmap Workshop," Sept. 1999, Energetics, Inc., Columbia, MD, June 22-25, 1999, Chicago, IL, available at http://www.nrel.gov/ncpv/pdfs/25847.pdf .

6. SUBCONTRACT AWARD

Funding for potential awards is based on availability of DOE funding and on programmatic considerations as decided by the DOE and NREL. Although price participation (cost-sharing) is not required, it will receive additional consideration during evaluation. Price participation may be in the form of labor, and/or equipment. Current plans are to limit NREL's price participation (cost share) for each award to $0.5 million for any single company or university. Most awards will be smaller.

It is the intent of NREL to make multiple, firm, fixed-price subcontract awards under this procurement. NREL reserves the right to make any number of awards or not to make any awards under this solicitation document. **There are no capital equipment funds available under this solicitation.** Capital equipment is defined as equipment with a unit value of $5,000 or more, including applicable shipping and installation charges, and having a life expectancy of two years or more.

It is anticipated that the program funding available under this solicitation document will be approximately $3-$5 million in FY2001. It is possible that funding available to HiPer PV may increase during the course of the program.

The period of performance of all of the awards will be *two years*, corresponding to Phase I of the HiPer PV.

7. COMPETITIVELY SOLICITED LETTERS OF INTEREST USING BEST VALUE SELECTION

This procurement shall be conducted utilizing Best Value Selection (BVS), which seeks to select a letter of interest based on the **best value combination of qualitative merit and price of the letters of interest submitted**.

BVS evaluation is based on the premise that, if all letters of interest are of approximately equal qualitative merit, award will be made to the Interested Party with the lowest evaluated price. However, NREL will consider awarding to an Interested Party whose letter of interest demonstrates higher qualitative merit if the difference in price is commensurate with the higher qualitative merit. Conversely, NREL will consider making award to an Interested Party whose letter of interest demonstrates lower qualitative merit if the price differential between it and other letters of interest warrant doing so.

The following qualitative merit criteria establish what NREL considers to be valuable in a letter of interest. These qualitative merit criteria will permit selection of the letter of interest that provides better qualitative merit for a reasonable marginal increase in price. All letters of interest will be judged against these qualitative merit criteria. Interested Parties should provide adequate information on all of these qualitative merit criteria (in addition to adequate price information) to permit proper evaluation.

NREL will evaluate letters of interest in two general steps:

Step One. An initial evaluation will be performed to determine if all required information has been provided for an acceptable letter of interest. Interested Parties may be contacted only for clarification purposes during the initial evaluation. Interested Parties determined not to be acceptable shall be notified and excluded from further consideration.

Step Two. All acceptable letters of interest will be evaluated against the requirements in this solicitation, the program policy factors, and the qualitative merit criteria listed below. Based on this evaluation, NREL has the option, depending on the specific circumstances of the letters of interest received, to utilize one of the following methods: (1) Make selection and award without discussions; (2) Make selection after discussions with all finalists, and then enter into negotiations only with the successful Interested Parties; (3) Conduct parallel negotiations with all acceptable Interested Parties or finalists and then make selection; or, (4) After discussions with all finalists, select successful Interested Parties for parallel negotiations and then make selection.

8. QUALITATIVE MERIT CRITERIA FOR BEST VALUE SELECTION

The following are qualification criteria within this LOI solicitation. These considerations are paramount to the purpose of this solicitation. NREL will eliminate at its discretion any letters of interest that do not fit the criteria given below. **Interested Parties failing to meet these criteria will not be evaluated for an award and will be considered non-responsive to this LOI solicitation**.

- Initial manufacturing must occur in the United States.

The following Qualitative Merit Criteria shall be used to evaluate letters of interest. Qualitative Merit Criteria A will be weighted more heavily than B or C.

L. Technical Quality and Relevance of the Proposed Technical Plan/Approach

- The extent to which the letter of interest demonstrates awareness of the current and past status of relevant PV technologies.
- The clarity and substance of the discussion of what the letter of interest states can be added to the current and past status of relevant PV technologies.
- The quality of the technical approach and the experimental design.
- Identification of challenges and problems and the feasibility of solutions proposed for these.
- What will be accomplished by the proposed research, how relevant is it to the HiPer PV's stated targets for Phase I?
- How far along the path to HiPer PV's Phase II and III Targets (Table 1) will this take HiPer PV, and will this research help to determine the direction to go next.

B. Capabilities

- The availability, qualifications, and past performance of the technical personnel, as well as the resources, experience, and flexibility of the Interested Party'steam.
- Documented prior success of the proposing team with PV and other technologies as related to their proposed work.

C. Price Reasonableness

The Interested Party's estimated price shall be evaluated in accordance with the following subcriteria:

- Reasonableness of the total estimated price and the individual cost elements which comprise the total estimated price.
- Demonstrated understanding of the project based upon the price estimated to perform the work.
- Demonstrated understanding of the risk involved based on the estimated price proposed.
- Reasonableness of the estimated price proposed in relation to the magnitude of the work to be performed.
- Level of price participation (not a requirement).

9. PROGRAM POLICY FACTORS

Program Policy Factors will be evaluated in addition to the Qualitative Merit Criteria above.

HiPer PV will consider the following program policy factors in making its competitive range determination and final negotiation rank order. This is in addition to the Qualitative Merit Criteria (above). These program policy factors are not weighted:

- The need to have a mix of technologies.
- The need to focus emphasis on the most promising technical approaches to meeting the long-term, cost and performance goals.

- HiPer PV anticipates funding diverse research; and letters of interest will be selected so that no key issue is neglected.

10. GENERAL INSTRUCTIONS FOR INTERESTED PARTIES

- You must submit the Estimated Budget Sheet (Attachment 1), for each of the two years plus the total for the two years, with your letter of interest.

- You must submit the "Representations and Certifications" (Attachment 2) with your letter of interest.

- Your proposed price must be valid for 190 days from the date of your letter of interest.

- A letter of interest may be submitted for one or both categories: 1) Thin Film Multijunctions and Concentrators (per Section 5.A above), and 2) III-V Concentrator (per Section 5.B above.). Separate letters of interest must be submitted and should clearly state the specific category.

- A Sample Subcontract (Attachment 3) and the NREL appendices (Attachment 4) are for your reference.)

- This solicitation DOES NOT allow for the submittal of facsimile or electronic letters of interest.

11. REQUIRED INFORMATION

Letters of interest should include the following, in an original AND nine (9) copies:

- A title page, to include the letter of interest title, name of organization, and principal investigator (with postal address, telephone number, fax number, and e-mail address). The title should be succinct and capture the essence of the letter of interest. It should be clear as to which area the letter of interest is for: Thin Films or III-V Concentrators.

- A proposed Statement of Work (see Appendix 1, below, for template) that forms the bulk of the letter of interest and includes:

    - A brief Statement of the Problem and its history

    - A Technical Approach, including planned experiments

    - A brief Statement of Anticipated Problems recognized, and recommendations for how they may be overcome

    - A Statement of Expected Results and a Proposed Schedule for major project tasks. Include indication of how the expected results will help to define the next research step toward reaching our stated 2010 Targets (Table 1). The proposed schedule for the R&D will include milestones and deliverables. Milestones may relate to understanding developed as a result of the R&D on critical issues affecting the progress or redirection of the R&D, and may be material samples or devices demonstrating the progress, or best current status of the research effort. Formal deliverables should include Monthly OR Quarterly Reports, and a Final Technical Report (to be submitted electronically and in hard copy).

    - References and Bibliography. Relevant references may be cited, but do not include copies of reference articles in the submission.

    - Summary of Capabilities

- Abbreviated Resumes (one page maximum) of One or Two Key Personnel

- Selected list and brief description of Government or NREL contracts or subcontracts related to the field covered by this LOI that the Interested Party has been awarded in the past five (5) years, to include the contracting agency's name, the contract or subcontract amount, and a brief description of the project.

In addition, letters of interest should include one (1) original (no copies necessary) of the following:

- A completed "Representations and Certifications" (Attachment 2).

You should provide only the minimum amount of information required for proper evaluation. Keep your letter of interest as brief as possible, and concentrate on substantive information. Follow the instructions below in preparing your letter of interest:

C Keep your proposed Statement of Work to no more than 15 pages (not including the title page, "Representations and Certifications," resumes, and Budget Sheet).

- A page is defined as one side of an 8 ½" x 11" sheet of paper.

C Use a 12-point font.

C Maintain at least 1-inch margins on all sides.

C Copies may be either single or double sided.

12. LATE SUBMISSIONS, MODIFICATIONS, AND WITHDRAWALS OF LETTERS OF INTEREST

Letters of interest, or modifications to them, received from qualified firms after the latest date specified for receipt may be considered if received prior to evaluation, and NREL determines that there is a potential cost, technical, or other advantage, as compared to previous letters of interest received. However, depending on the circumstances surrounding the late submission, NREL may consider a late letter of interest to be an indication of the Interested Party's performance capabilities, which could result in downgrading of their letter of interest by NREL evaluators in the technical evaluation process.

Letters of interest may be withdrawn by written notice or telegram (including mailgram) received at any time before award. Letters of interest may be withdrawn in person by an Interested Party or an authorized representative, if the representative's identity is made known and the representative signs a receipt for the letter of interest before award.

13. RESTRICTION ON DISCLOSURE AND USE OF DATA

Interested Parties who include in their letters of interest data that they do not want disclosed to the public for any purpose or used by the Government or NREL except for evaluation purposes, shall --

A. Mark the title page with the following legend:

> "This letter of interest includes data that shall not be disclosed outside the Government or NREL and shall not be duplicated, used, or disclosed--in whole or in part-- for any purpose other than to evaluate this letter of interest. If, however, a subcontract is awarded to this Interested Party as a result of--or in connection with--the submission of this data, the Government or NREL shall have the right to duplicate, use, or disclose the data to the extent provided in the resulting subcontract. This restriction does not limit the Government's or NREL's right to use information

contained in this data if it is obtained from another source without restriction. The data subject to this restriction are contained on pages [*insert page and line numbers or other identification of pages*]"; and

B. Mark each page of data it wishes to restrict with the following legend:

"Use or disclosure of data contained on this page is subject to the restriction on the title page of this letter of interest."

14. DISCLAIMER

NEITHER THE UNITED STATES, NOR THE DEPARTMENT OF ENERGY, NOR MIDWEST RESEARCH INSTITUTE, NATIONAL RENEWABLE ENERGY LABORATORY DIVISION, NOR ANY OF THEIR CONTRACTORS, SUBCONTRACTORS, OR THEIR EMPLOYEES MAKES ANY WARRANTY, EXPRESSED OR IMPLIED, OR ASSUMES ANY LEGAL LIABILITY OR RESPONSIBILITY FOR THE ACCURACY, COMPLETENESS, OR USEFULNESS FOR ANY PURPOSE OF ANY OF THE TECHNICAL INFORMATION OR DATA ATTACHED AS ENCLOSURES OR OTHERWISE PROVIDED HEREIN AS REFERENCE MATERIAL.

15. PROTESTS

Please note that the General Accounting Office and the Department of Energy no longer accept or rule on protests from Subcontractors. DEAR 970.7106 and 970.7107 which prescribes procedures for the handling of mistakes in bid situations in purchasing by M&O contractors and protests of M&O contractor procurements have been deleted from the DEAR. Should an Interested Party have any concerns regarding an NREL selection determination, the Interested Party may contact Marty Noland, Advocate for Commercial Practices at (303) 384-7550. If concerns are registered by a subcontractor, NREL will address each concern on an individual basis.

16. SIC CODE AND SMALL BUSINESS SIZE STANDARD

A. The standard industrial classification (SIC) code for this solicitation is 8731, 8732, and 8733.

B. The small business size standard for 8731 is 500 or less employees.

C. The small business size standard for 8732 and 8733 is $5.0 million in annual receipts.

(Annual Receipts of a concern means the annual average gross revenue for the last three fiscal years.)

Appendix 1
Proposed Statement of Work
"High Performance PV, Phase I: Identifying Critical Paths"

Title

(Indicate Either Thin Films or III-V Concentrators)
Date

1.0 Background

Statement of the Problem and History

Statement of Technical Approach

Statement of Anticipated Problems

Statement of Expected Results and how they relate to the initiative's goals
Include indication of how the expected results will help to reach both the Phase I targets and the next research steps toward our stated 2010 Targets (Table 1).

References and Bibliography. Relevant references may be cited, but do not include copies of reference articles in the submission.

Capabilities of the Interested Party, especially in the proposed area of work (include requested resumes and a list of related contracts as attachments)

2.0 OBJECTIVE

The specific objectives of this proposed work are to:

3.0 SCOPE OF WORK/TASKS

State summary of proposed work:

YEAR I

During Year I, the following tasks will be performed:

3.1 Task 1 Title

Abbreviated task description.

3.2 Task 2 Title

Abbreviated task description.

Continue to list tasks as necessary.

YEAR II

During Year II, the following tasks will be performed:

3.3 Task 3 Title

Abbreviated task description.

3.4 Task 4 Title

Abbreviated task description.

Continue to list tasks as necessary.

4.0 PROGRAM PLAN

The research shall be carried out according to the proposed Task Schedule outlined below. If awarded a subcontract, it is expected that all Milestones, Deliverables, and Reporting Requirements shall be met by the Interested Party according to the schedules detailed in the appropriate sections that follow.

4.1 TASK SCHEDULE

Task Schedules are broken down into separate Year I and Year II efforts. These tasks will be performed according to the following schedules:

YEAR I

The following tasks and deliverables will be performed and completed during Year I according to the following schedule:

Months	1	2	3	4	5	6	7	8	9	10	11	12
Task 1	• • •	• • •	• • •	• • •	• • •	• • •	• • •	• • •	• • •	• • •	• • •	• • •
Task 2	• • •	• • •	• • •	• • •	• • •	• • •	• • •	• • •	• • •	• • •	• • •	• • •
Etc.	• • •	• • •	• • •	• • •	• • •	• • •	• • •	• • •	• • •	• • •	• • •	• • •
Monthly OR Quarterly Reports	• • •	• • •	• • •	• • •	• • •	• • •	• • •	• • •	• • •	• • •	• • •	• • •

YEAR II

The following tasks and deliverables will be performed and completed during Year II according to the following schedule (the fourth Quarterly or last Monthly is replaced by the Final):

Months	1	2	3	4	5	6	7	8	9	10	11	12
Task 3	• • •	• • •	• • •	• • •	• • •	• • •	• • •	• • •	• • •	• • •	• • •	• • •
Task 4	• • •	• • •	• • •	• • •	• • •	• • •	• • •	• • •	• • •	• • •	• • •	• • •
Etc.	• • •	• • •	• • •	• • •	• • •	• • •	• • •	• • •	• • •	• • •	• • •	• • •
Monthly OR Quarterly Reports	• • •	• • •	• • •	• • •	• • •	• • •	• • •	• • •	• • •	• • •	• • •	• • •
Final Report	• • •	• • •	• • •	• • •	• • •	• • •	• • •	• • •	• • •	• • •	• • •	• • •

4.2 MILESTONE AND DELIVERABLE SCHEDULE

The following milestones/deliverables will be performed and completed by the dates indicated:

(Note that milestones/deliverables may be material samples or devices demonstrating the progress or best current status of the research effort.)

YEAR I

Proposed Milestones/Deliverables		Due Date	Task #
m-1.1.1	Description of first milestone or deliverable.		(Task #)
m-1.1.2	Description of second milestone or deliverable.		(Task #)
m-1.1.3	Continue to list as necessary...		(Task #)
m-1.1.4			(Task #)

YEAR II

Proposed Milestones/Deliverables		Due Date	Task #
m-2.1.1	Description of first milestone or deliverable.		(Task #)
m-2.1.2	Description of second milestone or deliverable.		(Task #)
m-2.1.3	Continue to list as necessary...		(Task #)
m-2.1.4			(Task #)

5.0 REPORTING AND PRESENTATION/TRAVEL REQUIREMENTS

In addition to the milestones/deliverables above, state whether monthly or quarterly reports will be submitted, in addition to a Final Report.

If a Subcontract is awarded, deliverables would be sent to the NREL Technical Monitor (hard and electronic copies) with a hard copy of the report (or transmittal letter) sent to the NREL Subcontract Administrator:

Attendance at NREL Subcontractor Annual Review Meetings to be held in the U.S. at a place and time specified by NREL would be required if an award is received. Any other travel should be detailed here.